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Contents

The Manufacture of Glue

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THE MANUFACTURE OF GLUE

Introduction

THOUGH glue appears to be an ordinary and a cheap product, it is one of those substances that have their value in various industries. Considering its several uses in many an industry it is worth while studying its manufacture. It is seen that glue has its valuable use in paper-making, manufacture of matches, book-binding, ship-building, carpentry and wood work, in the making of printing rollers, imitation and artificial leather and as sizing material in textile industries, etc. Glue in its purer form, which is known as gelatine, finds its way in confectionery and culinery work, photography, making of capsules for bitter drugs, coating of pills and in other fine works where purity and absence of smell, taste and colour are demanded. This pure form of glue is highly valued in bacteriological work.

Having an abundant supply of raw materials in the State for the manufacture of glue and finding its increased demand some attempts were made to study the various conditions necessary to get a satisfactory good product. The manufacture of glue looks so simple and easy at the onset that one is liable to think that it is not of high value to a capitalist. To an industrialist it looks so insignificant that he neglects to study the actual difficulties he would meet with during the course of the manufacture.

Several experiments were conducted at the Industrial Laboratory to prepare glue from various available raw materials and repeated tests of the prepared products were done in order to find out the exact defects and deficiencies and to modify the methods of manufacture. All kinds of glue may look alike outwardly but the regular examination of these will reveal their true worth.

Glue is an organic substance obtained from tissues, bones, tendons and skins of animals by extracting them in hot water and concentrating the liquid to a thick jelly like consistency which, when dried, should be hard,

usually light coloured, clear and transparent. There are two main kinds of glue manufactured—animal and vegetable of which the latter is not of much importance to us. Glue is a generic term now applied to that which is manufactured from animal matter and there are various kinds of these glues—the most important ones being bone glue and skin glue based on the nature of raw materials used which may be divided into two classes, *viz.*, wet and dry. Wet materials may be fresh sinews and cuttings, tendons, tissues and bones from slaughter houses and fleshings from tanneries, etc. Dry materials may be dried bones, stocked fleshings and sinews, preserved hoofs and feet, horn piths, cuttings and hide waste from tanneries, etc. Wet raw materials yield a better classed glue of a higher binding power and in fact in a greater quantity than the dry materials. But in the case of dry materials prolonged heating is necessary which often affects the gelatinisation property and yields a product of inferior quality. In spite of these advantages it is almost impracticable to establish a glue factory on a commercial scale working mainly with wet materials. In large factories they are to be placed in weak lime pits for a sufficient length of time, and dried in open air and then stocked for future use.

Glue manufactured from bones is different from skin glue on account of chondrin which is the main constituent of bones having a less binding power than glutin of the skin. It is thus evident that glues manufactured from different consituents must vary in properties and prices.

The Process of Manufacture

Many experiments were conducted in order to study carefully the regular process for the manufacture of glue from bones and other raw materials. The manufacture of glue from bones has to pass through the following stages :—

1. *Crushing.* For efficient treatment bones are broken into smaller fragments either by hand crushing or by passing through a grinding mill as one finds necessary.

2. *Degreasing, or removal of fat.* Bones generally are said to contain about 12 to 14 per cent fat which must be removed as much as possible before extraction. The

recovered fat forms a bye-product in the glue manufacture. The degreasing is carried out by either of the following three methods, *viz.*, (*a*) boiling in open pans, (*b*) steaming under low pressure and (*c*) soxhletting. Boiling in open pans removes only about 6 to 7 per cent of fat. Although steaming under low pressure extracts more fat, it is not preferred as it lowers the glue contents. Soxhletting with petroleum ether dissolves out about 10 per cent of fat but invariably colours it which necessitates bleaching to fetch a good price. Experience shows that degreasing of bones by open steam boiling is more economical and preferable.

3. *Cleaning.* A little treatment with dilute sulphuric acid is necessary to get a good product of glue. This enables the dissolution of the hard matter and in fact if kept too long with repeated fresh acid most of the matter dissolves out leaving only pure ossein which is soluble in hot water giving the purest form of glue. Since this is an expensive process, bones are soaked in only dilute acid solution for some time, removed from the bath and washed free of acid. This preliminary treat ment is found to curtail a portion of the difficulty which is usually met with during clarification.

4. *Extraction of glue.* Open steam boiling for a long time could be resorted to but since the extraction of glue from bones is done with some difficulty unlike that from sinews and tendons steaming under pressure is necessary. The cleaned bones are kept in wire baskets enclosed in long cylinders with sufficient water and digested in an autoclave at 20 lbs pressure for two to three hours. On lifting the wire baskets the glue solution left behind in the cylinders is taken out and a fresh quantity of water is added for a second extraction. In some cases it may be necessary to have a third digestion depending upon the nature of the bones. All these extracts are mixed together for the next process. The residue left behind after extractions can easily be powdered when dried. It contains mostly calcium phosphate which on treatment with sulphuric acid gives super-phosphates so highly priced by the agriculturists for its manurial value. An average yield of about 13 to 14 per cent of glue is obtained on the weight of stocked bones when subjected to steam at about $1\frac{1}{2}$ atmospheric pressure for 2 to 3 hours.

5. *Clarification.* Clarification of the glue solution becomes necessary if the bones are not prepared well before extraction. For ordinary commercial glue clarification is not needed but the extracted solution, when allowed to settle, clears itself by sedimentation and may be decanted and filtered. But in the case of high grade glues and in the manufacture of gelatine (which is only a purer form of glue made into thin sheets) it is essential to clarify the liquid.

Clarification can be done by several chemical and mechanical agents but in some cases the binding property seems to be affected. Clarification by filtration through paper and a mixture of washed sand and animal charcoal is found helpful only when two much colloidal matter is not present. Among all albuminoid clarifiers white of an egg is found most satisfactory but unfortunately its use is prohibitive on account of the high cost. Chemical agents such as alum, borax, etc are also useful. The addition of a small quantity of saturated alum solution to the cooled extracted liquid followed by a sufficient amount of ammonia and heated to boiling forms a very satisfactory clarifier. On filtration a clear bright solution is obtained.

The only precaution necessary during this process of clarification is to use such agents that do not affect the binding property of glue and experiments show that alum ammonia addition affects it in the least. A little practice will enable one to regulate the amount of clarifying agents to be added which naturally depends upon the amount of colloidal matter and hence the percentage of glue in the liquid.

6. *Concentration.* The clear filtrate obtained does not set by itself since it is in a diluted form and hence it requires concentration to a thick consistency. But, as already pointed out that prolonged heating and boiling affects the gelatinisation property, concentration of the liquid should be carried out in vacuo under reduced pressure. It may be possible in large factories to have specially fitted up vacuum apparatus but in petty cottage establishments where concentration cannot be done under reduced pressure, the liquid should be concentrated in a double jacketted pan or on a water bath.

Concentration of the liquid on a water bath requires constant stirring to prevent the film formation on the surface but the liquid gets slightly deeper in colour and possesses lesser binding power in contrast to concentration in Vacuo. It is the concentration of the liquid that very often lowers the quality of the product.

7. *Decolorisation.* If the concentrated liquid is dark or high coloured it necessitates bleaching. For high grade glues bleaching is done by passing So_2 in the liquid, which lightens the colour of the product to a very great extent. This decolorised liquid when poured over glass slabs in a thin layer should appear colourless and transparent on setting. For ordinary commercial glue where binding property is only needed, bleaching the liquor is considered a waste. There are other decolorising agents such as hypochlorite, hydrogen peroxide, chlorine, ozone, etc but they will be found expensive to a glue manufacturer. So_2 has further advantage being not only efficient decoloriser but also serving as antiseptic to glue.

8. *Moulding.* A little experience will show the exact stage when the thick jelly-like liquid is to be poured in tin moulds made for the purpose and kept lightly smeared with cocoanut oil. In large factories bigger moulds are made and the substance, when partially dried is removed from the moulds to be cut into smaller blocks for stocking and transport convenience. Experience will also show the exact stage when these have to be removed from the moulds after setting for cutting purposes.

9. *Desiccation.* The last stage and the most important of all is the drying of glue. The moulds are kept in cool place for drying and after three or four days the blocks of glue are carefully removed from the moulds, dried on wire netting stretched in a frame and are exposed to free air all round. This takes another day or two for complete drying when they can be easily taken off the wire netting. Sometimes drying of blocks in the moulds takes a longer time and when the imperfectly dried blocks are kept on wire netting in this state they are liable to drible through the meshes. This condition is to be guarded against.

Particular attention should be paid to the surroundings and environments such as humidity of air, temperature, cleanliness, etc., as it sometimes happens that glue takes much longer time to set in moulds and in few cases would never set which, in the absence of bacterial infection, indicates either the glue had been improperly treated or certain unfavourable conditions of weather have affected it.

Sometimes it happens that the glue sets very quickly leaving a thick wrinkled surface on the top which prevents the drying of the inner portions. Often it happens that the glue dries in a short time getting so hard and brittle that cracks and fissures generally form all over the surface making the substance so fragile that it crumbles to powder.

All these phenomena are observed when there is the play of variations in temperature and humidity of the atmosphere. Hence it is said that hot air drying chambers and cooling chambers are necessary to have a uniform and satisfactory product. In different seasons of the year glue behaves in different ways and a careful study ought to be made by the manufacturer with regards the various conditions necessary for favourable drying. But when no special arrangements were made it was found practicable in Hyderabad to work with confidence for about six months (from October to March) and during the other six months certain difficulties may sometimes be met with during the process of drying. Either it would set so quickly as to be brittle and crumble to pieces or it would take a very long time to set and become mouldy. But even in this part of the year the manufacturer can get on with his work if only he pays particular attention to drying the product in suitable rooms built for the purpose. In extreme summer the drying room should be kept cool and during the rains when there is damp air all round the room should be well closed and heated if possible.

Bacterial Infection

The success of glue manufacture lies in the act of drying the product properly and in the prevention of bacterial infection which is to be carefully guarded against. All kinds of micro-organisms being present in

the air, slight conditions in any substance favourable for the growth of bacteria will give an easy access to infection and much more so when there is undue moisture in the substance and the surrounding air. Certain organisms there are such as *Bacterium termo* and *Bacillus subtilis* which not only putrify the substance but will also liquify the jelly permanently making the glue totally unfit for use. When the glue solution gets liquified *Bacterium termo* will more often be found on microscopical examination, the characteristic feature of this being intense motility. *Bacillus subtilis*—the ordinary hay bacillus also liquifies glue permanently—which should not be confused with the former bacteria. There are certain organisms that cause only mouldiness to the substance by which the clarified condition is lost but no liquification occurs. When there is undue dampness in the surrounding air green fungoid growths are at times found on the surface of glue, and can be easily wiped off with a damp cloth leaving the glue quite unaffected. Generally the organisms most dreaded are those of the *Bacterium termo* group since they affect the very constitution of glue.

Conditions most favourable for the growth of such objectionable bacteria are chiefly undue moisture, the presence of nutrient substances such as phosphates, etc, unclean surroundings and careless handling—all these giving room for ready contamination. In cases where infection is feared it is advisable to add little antiseptics such as mercury perchlor, formaldehyde, acid carbolic, salicylic, boric, etc. without in any way affecting the chief properties of glue. But most of these antiseptics should be made use of only in the manufacture of low grade glues. In the case of high grade glues and gelatine which are often used in culinary and confectionery purposes, it is dangerous to use such antiseptics. Salicylic and boric acids may be used only in small quantities with some confidence. Usually glue keeps well if the weather conditions are controlled and cleanliness observed in all the vessels and surroundings. Slight signs of bacterial infection should be at once noted and proper precautions taken to check the spread, otherwise the setting property or the binding power of glue is affected. Careful attention is therefore needed while drying the jelly, the practical experience of which will enable one to have an easy control over this risk.

Bye-Products

Although glue making is considered a small industry it has several bye-products which add to the profits of the industry. Before extraction the best bones are selected for the making of buttons, walking stick, umbrella and knife handles, paper cutters and other fancy articles. And all the condemned and spoilt bones are subjected to destructive distillation to get bone oil, pyridine, tar, etc every one of which has its own value. By incinerating the waste bones, bone charcoal which has many uses in the present day industries is obtained. Besides, as already pointed out, there is the bone fat which has a good demand and lastly but not the least there are highly valued calcium and super-phosphates.

Other Glues

Apart from bone glue experiments were conducted in the making of glue from other raw materials such as sinews, fleshings, tendons and horn cores the latter of which gave a finer and clearer form of glue. As regards the process of manufacture it is almost identical to that described under bone glue except that in some cases degreasing is not found necessary. In large factories, as in the case of bones, it is not possible to work always with fresh raw materials which also require preparation. These raw materials are washed carefully in water for some time, soaked in weak solution of milk of lime and afterwards dried. When required for use they are first washed several times with fresh water, then delimed with very weak acid and washed again free of acid. Extraction under pressure is not necessary in this case but direct boiling on naked fire or on a water bath will suffice. One or at the most two boilings extract all the glue present and the third extraction is not necessary. The average yield of glue from sinews is about 25 per cent on the weight of dry sinews. If the material is prepared well to start with and then carefully extracted the process of clarification may be completely avoided. Similar precautions must be taken in drying the product in this case too.

Hide glue is the one generally employed by the carpenters and cabinet makers since it has a higher binding power and hence higher cost. Also he prefers slow drying glue to quick drying one since the former gives

depends upon certain particular requisites and, as already pointed out, a glue light in colour and good looking may fetch a lower price if found poor in its binding property. The manufacturer will have to pay as much attention to the testing of glue as he pays to the making since it will enable him to study the various defects and to have a better control over the process of manufacture in getting a standard uniform product, and it will be to his advantage to take a sample from every boiling for testing purposes. To the user in large quantities it is important in that he might be able to know the exact value of glue and will not get deceived by paying much more than what he ought to pay. Glutin which has a higher melting point and a better binding power is prominent in the hide glue and hence this glue is far superior to bone glue whose main constituent is chondrin.

In the testing of glue several points should be noted down of which few are only comparative. A good glue must possess the following characteristics :—

(1) It should be free from any smell whatsoever, light in colour and transparent.

(2) It should remain undissolved if left in water for 24 hours and be capable of absorbing about ten times its weight of water when soaked therein at 4_0 C.

(3) The jelly when cooled and set should be able to sustain a weight of $1\frac{1}{2}$ lbs. to 2 lbs. per square inch.

(4) It must be thoroughly dried to avoid development of moulds on the surface.

In spite of the fact that glue is generally used as an adhesive and only its binding property is to be observed carefully, it is necessary to test glue for other qualities also. Often glue is to be tested for the following :—Colour, smell, moisture, shrinkage, ash, water absorbing power, absorbtion of moisture in damp air, jelly strength, capacity of drying, acidity, viscosity, breaking strain or binding power, foam test and keeping properties.

A series of tests made in the laboratory on several samples both Laboratory and foreign products necessitated certain improvements in the manufacture. The preliminary tests made on one of our first glue products from sinews gave the following results which though not satisfactory may be of interest when compared to the best foreign glue and this led us to improve the quality further.

1. *Colour.* Foreign. Clear but dark red.

   Laboratory Made. Clear and light coloured.

2. *Smell.* Foreign. Free from smell.

   Laboratory. Do but owing to the previous application of oil to the moulds the sample possessed a little oily smell.

   Glue has a characteristic smell which is often more prominent in hot solution than in cold.

3. *Shrinkage.* Foreign. On exposure for a long time the surface was full of cracks.

   Laboratory. Do do

4. *Moisture.* Foreign. 12·77 per cent.

   Laboratory. 14·43 per cent.

   Average percentage of moisture is about 12 to 14. Lower than this average gives less tenacity and resisting power and a higher percentage diminishes the keeping property of glue.

5. *Ash.* Foreign. 3·65 per cent. slightly alkaline.

   Laboratory. 4·22 per cent. alkaline.

   It is the ash that sometimes helps one to find out the source of glue. The ash of glue made from hide shows high percentage of lime on account of liming the skins and is invariably alkaline to litmus and that made from bones contains phosphates of lime and magnesia. Sometimes lead and zinc salts are used specially to increase the adhesive property and hence these give an increased weight to the ash.

6. *Water absorbing power.*

Foreign. A piece left in water for 24 hours at room temperature got dissolved completely.

Laboratory. Do

This should be left soaked in water at about 4°C for 24 hours when it should absorb about 8 to 9 times its weight of water but must not go into solution without heating.

7. *Strength of jelly.*

To test the strength of jelly a convenient form of apparatus was improvised by taking flat bottomed glass tubes 4″ long by 1″ to 2″ in diameter and on the top of these tubes tin lids with a hole in the centre are fixed giving access to a metal rod provided with a cup shaped disc at the lower end and a flat disc on the top to support the weights. Glue solution of a specified strength is now poured in the tube and cooled and the lid replaced with the cup shaped disc gently resting on the surface of the jelly. Weights are gradually put on the top disc until the ower one completely sinks into the jelly.

These experiments are only comparative and should be done under similar conditions paying attention to the calibre of the tubes, the strength of the glue solution, temperature to which the solution is heated and the setting of jelly, gentle addition of weights and the depth to which the lower disc sinks into the jelly substance, etc.

A solution of 15 per cent. cooled in ice supported the weights given below :—

Foreign. Sliding started at 105 gms. and the lower disc went completely under the surface at 150 gms.

Laboratory made. Started at 75 gms. and completely sunk at 105 gms. showing a great weakness in jelly strength.

8. *Capacity of drying.* 10 per cent. solution made and poured on glass slabs in a thin layer.

Foreign. Dried within 2 hours and when kept longer it crumbled and separated itself from the plate in small pieces.

Laboratory Do do

9. *Viscosity.* 3 per cent solution made in both cases and tried in a burette as compared to water (all these at the same temperature) and uniform readings taken out, *i.e.*, a run of 50 c.cs. from the 20th c.c. to the 70th c.c. in the burette.

50 c.c. of a 3 per cent. solution run out from a burette between the readings 20th and 70th c.c. took 38 seconds for water.

39·5 seconds for foreign,

and 40 seconds for laboratory product.

10. *Breaking strain.* For this purpose uniform blocks of wood $3'' \times 1''$ were used with a hole sideways for attaching the wire so that when the blocks are glued together the upper block could be hung and to the lower block scale pan can be attached for the weights to be added gradually. Glue solution of a certain known strength is made and applied evenly to the surface of the blocks which are then joined together and pressed for some time under heavy weight till dried. After drying for a certain period one block is hung at a suitable place and to the lower one the pan is attached to which the weights are gently added.

Proper care should be taken as far as possible to procure blocks of uniform size with smooth and evenly planed surfaces for this purpose.

Even in this case similarity of conditious are necessary such as specified percentage of the glue solution, time of heating the solution, equal quantity of the solution for application, the number of coats applied, elasticity, compressibility, and the even surfaces of the wood blocks, similar manipulation, fixation and the compression under weight, also the time and the temperature of drying under weight and what is more the temperature of the solution

when applied to the blocks since hotter solution when applied gives greater breaking strain.

It is then this testing that reveals the true worth of a glue. A glue solution on cooling and remelting repeatedly has been found to possess a less breaking strain than the solution made for the first time of the same consistency and strength indicating that repeated heating and boiling of solution diminishes the binding power and affects the main constituents of glue itself.

Blocks of wood when pasted together with a 25 per cent solution of glue could not be separated after 1 day's drying by a weight of 60 lbs and similar results were noted with a 15 per cent solution after 3 hours drying. Hence a more dilute solution was used in all future experiments.

5 per cent. solution after half an hour's drying in shade.

Foreign. Weights sustained—38 lbs.

Laboratory made. Do 24 lbs.

5 per cent. solution after 1 hour's drying in sun—

Foreign. Weights sustained—56 lbs.

Laboratory made. Do 36 lbs.

11. *Foam Tests.* This is of importance since foaming or frothing is sometimes considered a great disadvantage in certain works and in fine joinery work. This particular behaviour of glue is generally caused either by the prolonged heating or by the presence of substances such as calcium hydrate, acids used in cooking and bleaching, zinc and other salts used as adulterants to increase the adhesive property of glue.

This test is done by shaking a known quantity of a particular strength of glue solution in a 250 c.c. graduated cylinder for some time and noting the volume of froth in inches and the time required for the froth to subside completely.

Foreign. 75 c.c. of a 10 per cent. solution on shaking for 30 seconds gave a 3″ foam and took 10 minutes to disappear.

Laboratory made. 75 c.c. of a 10 per cent. solution gave half an inch foam and disappeared in less than a minute.

When the two glued surfaces are rubbed it is sometimes noticed that frothing takes place all over the surface which is a great disadvantage as it interfers with the proper binding power and lessens the breaking strain.

Besides these original preliminary tests various other tests were made from time to time with the different species of glue prepared in the laboratory both under clarified and unclarified conditions. The results collated below are of interest inasmuch as they give sufficient data for important conclusions to be drawn :—

Jel strength.

Variety	Conditions	Moisture per cent.	Ash Weight per cent.	Jel power in gms.	
				Started at	Completed at
Sinews ..	Unclarified ..	10·79	2·82	45	145
Do ..	Clarified ..	9·20	2·72	35	115
Horn-piths ..	Unclarified ..	9·07	2·10	120	700
Do ..	Clarified ..	8·79	1·84	70	325
Bones ..	Unclarified ..	9·94	1·49	140	700
Do ..	Clarified	10·24	·99	100	350

(1) These results show that the use of certain chemical agents during the process of clarification affects the jel strength of the glue solution in general.

Binding power.

Strength of the solution.

——	1 per cent.		2 per cent.		3 per cent.		4 per cent.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Sinews glue-unclarified.	4	13	11	1	20	1	39	9
Do Clarified ..	3	13	6	7	8	9	10	9

Same time of drying for all cases.

(2) These results indicate that the binding power increases with the percentage of the glue solution. The higher the percentage of the solution, the greater the binding power until a maximum limit is reached beyond which all strengths of solution behave similarly.

Binding power.

Time of drying with a 4 per cent. solution.

——	1 hour		2 hours		3 hours		4 hours	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Sinews glue-Unclarified.	8	7	11	7	35	9	39	9
Do Clarified ..	5	13	6	9	8	13	10	9

(3) From this it is evident that the binding power varies according to the time of drying. The longer it is dried the greater the binding power until the maximum is reached.

Variety	Condition	Weight sustained in lbs.		
		Block No. 2	Block No. 3	Block No. 4
Sinews glue ..	Unclarified ..	46	63	over 63
Do ..	Clarified ..	16	28	38
Horn glue ..	Unclarified ..	33	51	over 63
Do ..	Clarified ..	24	39	51
Bone glue ..	Unclarified ..	31	49	62
Do ..	Clarified ..	26	36	51

4 per cent glue solution made in all cases and the blocks dried for 4 hours. Same blocks *viz.*, Nos. 2, 3, and 4 were used in all the tests.

(4) These results lead to the conclusion that the binding power of different glues varies with the nature of raw material used in the manufacture.

Viscosity. The solution maintained at 27°C were run through a burette between the 20th c.c. and the 70th c.c.

giving a flow of 50 c.c. under a constant pressure as compared to water at 27°C flowing between the same graduations and taking 40½″ for the flow of 50 c.c.

Variety	Percentage of solution	Time in seconds for a 50 c.c. flow	
		Unclarified	Clarified
Snews glue ..	1	42½	42
	2	43	42½
	3	45	43½
	4	47½	46
Horn glue ..	1	42	41½
	2	43½	42½
	3	44½	43½
	4	47	45½
Bone glue ..	1	42	42
	2	43½	43
	3	44½	44
	4	46	45

(5) These confirm the fact that clarification affects the viscosity making the solution thinner and hence a quicker flow.

Statement.

Foam tests.

Variety	Solution strength	Condition	Height of foam in inches	Time taken for the foam to disappear in minutes
Sinews glue ..	1	Unclarified ..	$1\frac{1}{2}$	5
	1	Clarified ..	$1\frac{3}{4}$	over 5
	2	Unclarified ..	$1\frac{3}{4}$	over 5
	2	Clarified ..	$2\frac{1}{2}$	over 10
	3	Unclarified ..	2	over 10
	3	Clarified ..	3	Persisting
	4	Unclarified ..	$2\frac{1}{4}$	More persisting
	4	Clarified .	$3\frac{1}{2}$	do
Horn glue ..	1	Unclarified ..	1	4
	1	Clarified ..	$1\frac{3}{4}$	4
	2	Unclarified ..	$1\frac{1}{4}$	5
	2	Clarified ..	2	5
	3	Unclarified ..	$1\frac{3}{8}$	8
	3	Clarified ..	$2\frac{1}{4}$	10
	4	Unclarified ..	$1\frac{1}{2}$	9
	4	Clarified ..	$2\frac{1}{2}$	15
Bone glue ..	1	Unclarified ..	$\frac{1}{8}$	1
	1	Clarified ..	$1\frac{1}{2}$	10
	2	Unclarified ..	$\frac{1}{8}$	1
	2	Clarified ..	$1\frac{1}{2}$	10
	3	Unclarified ..	$\frac{1}{2}$	$1\frac{1}{2}$
	3	Clarified ..	$1\frac{3}{4}$	over 10
	4	Unclarified ..	1	2
	4	Clarified ..	2	over 10

(3) These clearly indicate that clarification by means of certain chemical agents increases the height of foam in the solution when shaken and also lengthens the time required for the disappearance of the foam.

Commercial Aspect

"Will it pay me" is the question generally asked by an enterpriser before he undertakes to start an industry. Certain industries there are which are very tempting but do not pay in the long run. Few industries, though insignificant to think of, yield a high percentage of profit, the total amount recovered is necessarily small as the industry itself is a minor one but there are some industries that are very promising and give good profits.

One point of utmost importance is to enquire into the commercial aspect of an industry with a view to find out if a good demand for the manufactured product exists which depends entirely on the fact as to how many uses the product could be put to in various industries. Thus the manufacturer has not only to study the making of a substance but also the selling of it.

Considering these various points it is a matter of interest to start a glue factory either on a large commercial scale or as a cottage industry with promising profits. Even with a petty capital of about four to five thousand rupees and with personal zeal and energy a small capitalist can have a factory which would give him a satisfactory living. For the use of such capitalists a scheme has been worked out which may be of interest.

Scheme for Glue Manufacture

Capital Rs. 5,000.

To work with 150 lbs sinews daily with an average yield of about 35 lbs glue per diem.

Details :—

(1) Apparatus.
(2) Building.
(3) Fuel.
(4) Raw material.
(5) Chemicals.
(6) Running expenses (monthly).
(7) Income and profit.

1. *APPARATUS.*

(*a*) *Digester.* Outer jacket of cast iron 3′9″×2′6″ with lid and tightening screws, safety valve, pressure guage, etc.

Inner jacket of sheet iron, cylindrical 3′1″×2′1″ thickness $\frac{1}{8}$″.

Inside this a wire basket (with small meshes of $\frac{1}{4}$″ wide) strengthened all round by bands and with perforated sheet iron bottom 3′×2′ capable of supporting about 150 lbs weight when lifted.

(*b*) *Clarifier.* Shallow pans made of sheet iron 3″×1′4″ with handles—thickness $\frac{1}{8}$″.

(*c*) *Settling tank.* Circular, dia : 1′—height 3′ with handles—thickness 1/16″.

(*d*) *Evaporating pans* (*two*). Double jacketted.

Hemispherical pans with the diameter 2$\frac{1}{2}$′ and 1′ 4″ depth (greatest height) with an outside jacket enclosing the inner one with an inter space of 1″ all round—made of cast iron-thickness $\frac{1}{8}$″ and a lid on the top.

(*e*) *Moulds.* Made of tin 9″ × 6″ × $\frac{1}{4}$″—400 in number.

Drying racks—2 racks to contain 100 moulds. A rack 5′ × 3′ with 4 shelves all surrounded by wire gauze.

(*f*) *Boxes.* Dealwood 20″ × 14″ × 7″ (inside).

(*g*) *Filter pump.*

2. *BUILDING.*

Cemented pits for washing 3′ × 3′ × 2′.

A room with a furnace—masonry work.

A drying room and moulding room.

A store room.

Furnace. With few hearths and a chimney—1 for digester, 1 for clarifier and 2 for evaporators.

3. *FUEL.*

6 maunds of wood—2 mds. (digester) and 4 mds. (evaporator) to digest and evaporate. Rs.3 per day.

4. *RAW MATERIAL.*

150 lbs sinews a day at Rs. 2 per 100 lbs. Rs. 3.

5. *CHEMICALS.*

		Rs.	A.	P.
Alum— 1 lb. per 100 galls.	¾ lb. daily.	0	6	0
Ammonia ..	..	0	6	0
		0	12	0

6. *RUNNING EXPENSES-MONTHLY.*

	Rs.	A.	P.
Raw material	.. 90	0	0
Chemicals ..	.. 22	8	0
Establishment (3 coolies) ..	.. 50	0	0
Fuel	.. 90	0	0
Rent of building ..	.. 20	0	0
Interest on capital of Rs. 5,000	.. 50	0	0
Depreciation	.. 50	0	0
Total	..372	8	0

7. *INCOME AND PROFIT.*

Average yield of 35 lbs per day or 1,050 lbs per month or 525 seers at Re. 1 per seer. Rs. 525 per mensem.

A profit of about Rs. 152-8-0 per month. If worked carefully and economically the capitalist can aim at a higher profit.

This scheme is quite suitable for one that desires to start this industry on a small scale. But with a capital of about Rs. 10,000 and with improved methods of manufacture by perfect machinery and a good staff he could establish a suitable glue factory with encouraging profits. Then it necessitates the entire remodification of the scheme.

Conclusion

It is an undoubted fact that the manufacture of glue is of secondary importance to a tanner. He finds the fleshings, face and ear clippings, cuttings, etc. a waste and if he only utilises these waste products he could expect a a good yield of glue as a bye-product having an abundant and constant supply of raw materials with him. Hence glue forms a bye-product to the leather industry and as already pointed out the glue manufacturer will also have bye-products such as bone-meal, phosphatic manure and superphosphates, fat, charcoal, bone-oil, phosphorus etc which would further add to the profits of the factory.

Although the manufacture of glue can be taken up as a side industry by the tanner it can be handled as a separate industry by an individual enterpriser. It can be started either on a large scale or by a small capitalist as a cottage industry. In spite of the insignificant value of glue it has several valuable uses of its own in various forms and hence a constant demand of glue in different industries. As such the manufacture of glue would never fail to meet the demand. Especially in Hyderabad as there has never been a scarcity for the raw materials to a tanner, there could never be shortage of raw materials for a glue manufacturer.

The only precaution the manufacturer has got to take when he starts a factory of his own—either on a large commercial scale or as a cottage industry—is to bear in mind the undermentioned points :—He should select a site for the factory outside the city limits if possible, since sometimes the spot may be a nuisance to the public on the plea of insanitation. He should always try to keep the place clean and put a stop to dirt and rubbish accumulating to prevent putrefaction and thereby general ill-health. As a precaution while constructing or erecting the factory, care should be taken to see that floorings and drains are well set with even slope and devoid of cracks or crevices on the surface for the water to flow freely. He should also have an abundant and constant supply of good water free from any organic matter. If possible, all the washings and effluent from the place may be thoroughly treated either mechanically or chemically—and then drained away.

In selecting a site outside the city and the town limits he has an advantage in procuring an abundant supply of fuel at a lower price than that prevailing in towns.

Appliances necessary for the manufacture and other requisites could easily be made locally and at moderate rates. There is no trade secret in the manufacture of glue except that the important stages of extraction, desiccation and other processes must be thoroughly studied.

When all the necessary processes of glue manufacture are mastered there remains nothing to doubt why the manufacture of glue should not pay specially when there is an abundant supply of raw materals and there is an ever increasing demand for glue.

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